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# **Extended-Range Underwater Laser Imager**

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## **LONG-TERM GOALS**

Our goal is to develop and demonstrate a laser underwater imager capable of imaging through 7 – 8 attenuation lengths. The system will be designed to provide 1/4" resolution, and be compatible with nominal 12" diameter AUV systems. Eventually we plan to produce ruggedized versions for deployment in AUVs.

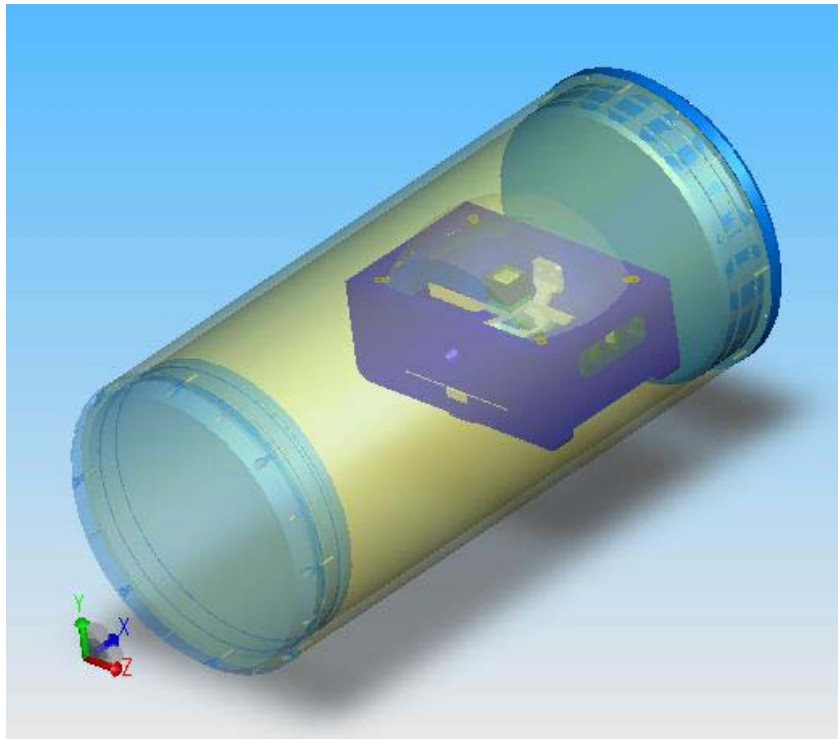
## **OBJECTIVES**

The near-term objective for the project (being carried out with SBIR funding) is to develop a breadboard prototype of the imager, and test and demonstrate the imager in a turbid-water test tank at Scripps Institution of Oceanography.

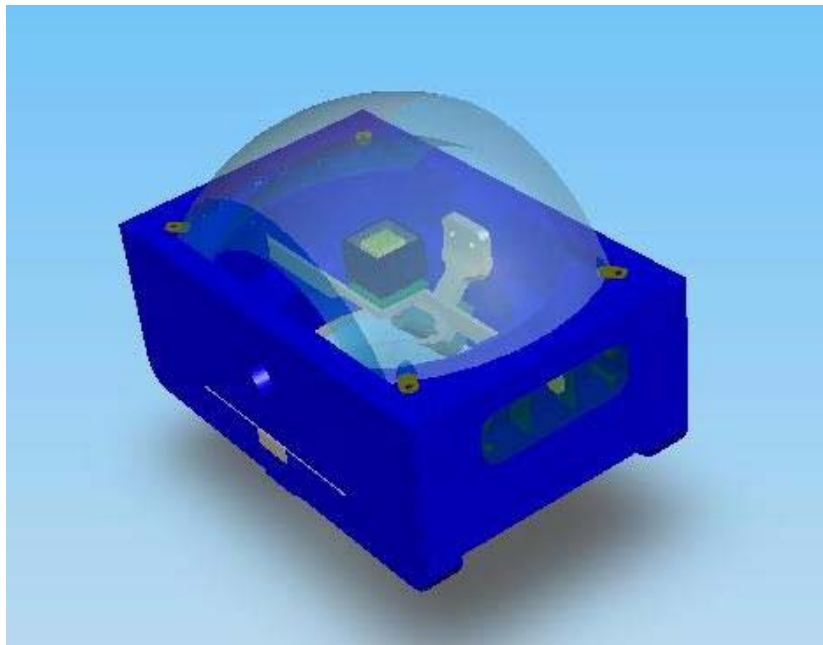
## **APPROACH**

The imager uses novel technology for both the transmitter and receiver. The transmitter is a frequency-doubled, 1 MHz repetition rate pulsed fiber laser producing about 6-8 Watts at 532 nm, whose beam quality enables excellent spatial resolution. A distinctive large-aperture, directional receiver discriminates against scattered light while efficiently collecting photons.

Dr. Jules Jaffe of Scripps is providing invaluable assistance with the project, including advice on underwater imaging, developing data systems, testing the imager, and analyzing the results.



***Figure: Concept drawing of the laser imager now in development, depicted within a 12-inch diameter AUV.***



***Figure: The hemispherical optical system of the receiver allows unusually large light collection aperture in a small-diameter payload. The transmitted laser beam is projected from the center of the hemispherical optical system, to provide a monostatic configuration.***

## **WORK COMPLETED**

The entire receiver optical system has been assembled and tested. Recent revisions to the receiver electronics design have been successful. The laser design and breadboard assembly is completed and the final version of the laser is ready for integration into the system.

## **RESULTS**

Early optical and electronic results are supportive of the eventual sensitivity goals for the project. The receiver's optical performance in light collection capacity and resolution meets the design goals. A unique photomultiplier and drive circuit is used to discriminate against photons scattered from the near-field of the imager system. With each laser pulse (at a 1 MHz repetition rate) the photomultiplier is gated off, then gated back on to detect and amplify photons scattered from targets of interest more than a few meters from the imager. The photomultiplier system is able to provide more than four orders of magnitude of discrimination against photons scattered from the seawater near the detector, while still providing high sensitivity for photons scattered of the slightly more distant targets.

The laser can now produce >5 Watts of green output with prime power input <150 Watts, which makes the design promising for use in UUVs. The system is undergoing final integration, and will soon be tested in a 10-meter tank at SIO.

## **IMPACT/APPLICATIONS**

Development of an imager capable of operating in extremely turbid water will facilitate both marine science studies, and tactical military operations as well. The spatial resolution of the system will greatly exceed that of sonar systems, enabling higher quality images for science, and unequivocal identification of potential munitions or other targets.

## **RELATED PROJECTS**

Other versions of the green laser used in the imager are being developed under contract N00039-06-C-0040 with SPAWAR, with the goal of providing efficient, multiwatt, high pulse repetition rate green lasers for undersea data communications. Another project under contract N68335-07-C-0291 has developed a modulated pulsed laser which could later provide a further upgrade in rejection of scattered light for the imaging system.